Spintronic Biochips for Biomolecular Recognition

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Integrated spintronic biochip platforms are being developed for portable, point-of-care, diagnostic applications. The platforms consist of a microfluidic unit where the bioassay takes place, an arraying and detector chip consisting of target arraying current lines and integrated magnetoresistive sensors, and electronic control and readout boards. Probe biomolecules are immobilized by microspotting over sensor sites, and target biomolecules, labeled with magnetic nanoparticles, are arrayed over the probe sites (magnetically assisted hybridization). After proper washing, hybridized targets are recognized by the fringe fields created by the magnetic beads, detected by the incorporated magnetoresistive sensors. Detecting geometries using out-of-plane or in-plane bead excitation and dc or ac detection/excitation will be reviewed. Detection limits using spin valve and tunnel junction sensors will be presented, depending ultimately on platform electronic noise and sensor noise characteristics. Applications to gene expression chips (cystic fibrosis gene mutation detection) and immunoassay chips (antibody-antigen recognition; E. coli, salmonella detection) will be presented.

Spintronic biochips are also being integrated into multi-module lab-on-chip platforms including biomolecule extraction from biological fluids (magnetophoresis), polymerase chain reaction (PCR) modules (if required), and the biomolecular recognition module. Alternative spintronic biochip geometries will also be presented (lateral flow biosensors), where a magnetoresistive reader scans the surface of a porous strip where labeled target biomolecules bind to immobilized probes.

Finally, a brief review of other biomedical applications of magnetoresistive sensors will be given, from hybrid sensors targeted at biomedical imaging, to magnetic tweezers/sensors for DNA translocation monitoring.